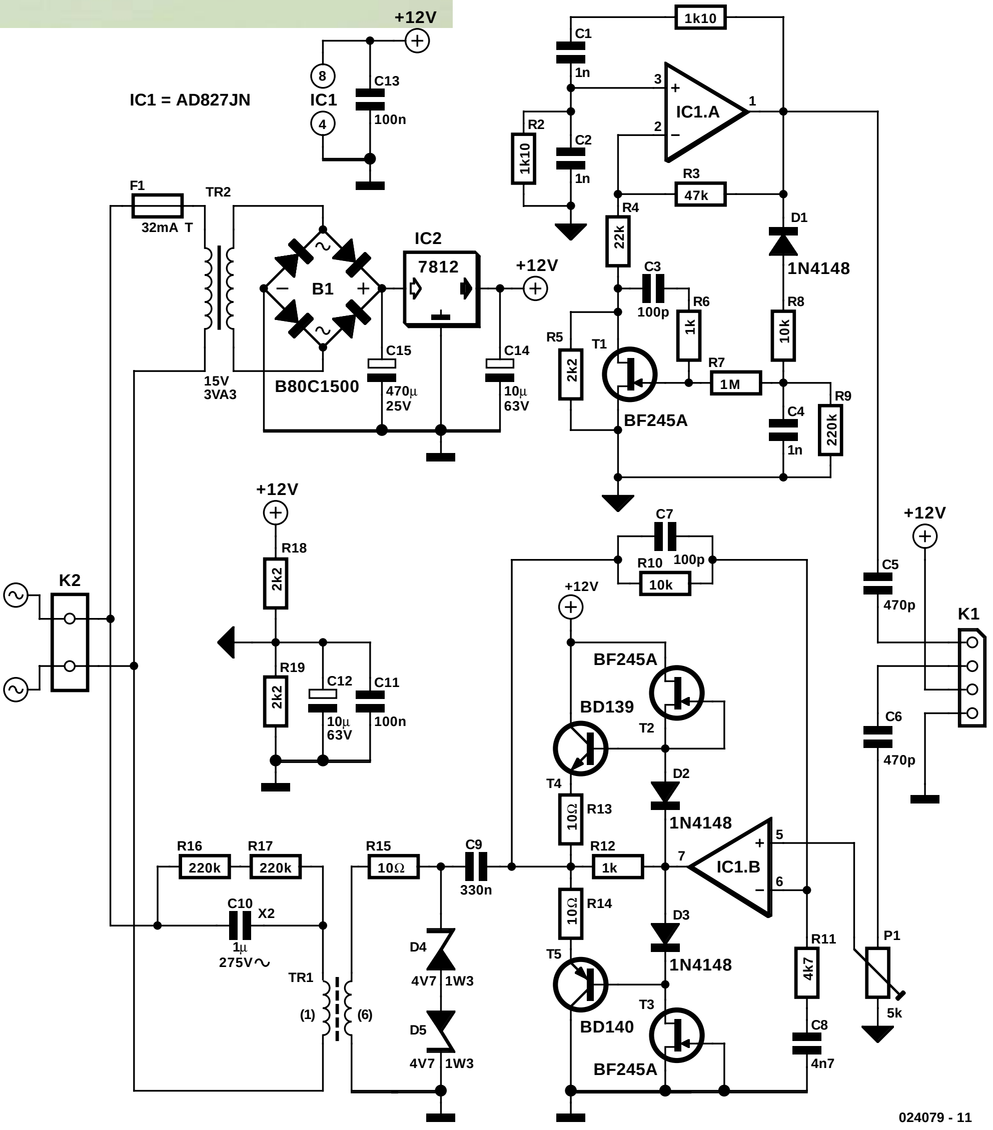
Mains Remote Transmitter

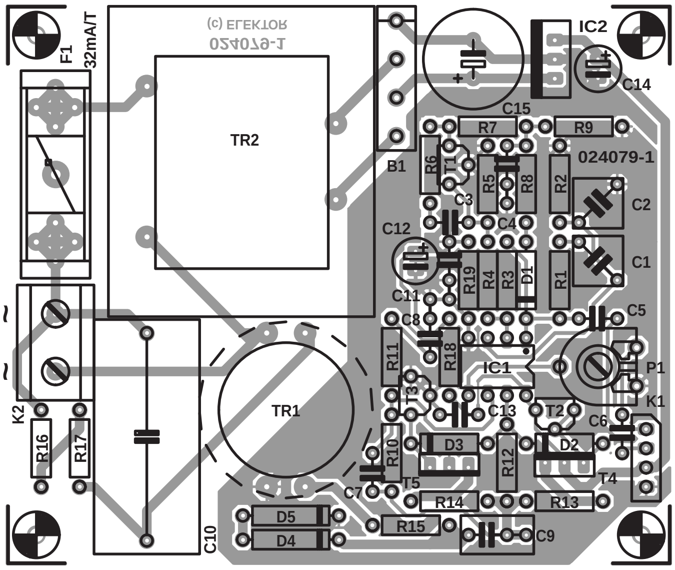
007

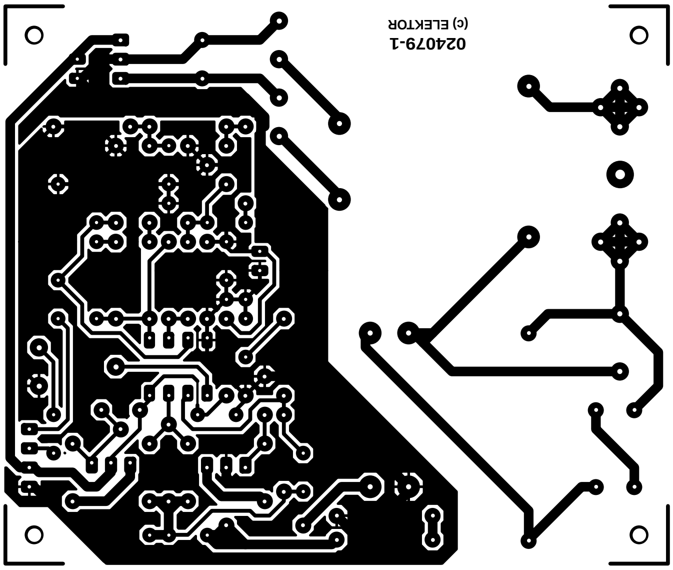
This circuit can be used to superimpose a 143-kHz carrier on the mains voltage, which allows various applications to be realised. One example is the 'Mains Remote Switch'. Besides the power supply, the circuit consists of only a sine-wave oscillator, a buffer stage and an output transformer for isolation from the mains network.

The oscillator, which is built around IC1a, is a standard Wien-bridge design whose frequency is determined by R1, C1, R2 and C2. The combination of R3, R4 and the amplitude stabilisation circuitry built around T1 provides a gain of 3. FET T1 is used here as a controllable resistance, with R6, R7 and C3 providing a certain amount of linearisation of the channel resistance. The output voltage is rectified by D1 to obtain a negative voltage (with respect to virtual ground), which is smoothed by C4/R9 and applied to the gate of T1 via R7. If the amplitude increases, the channel resistance increases due to the larger negative gate voltage, so the gain of IC1a decreases. The characteristic of the FET thus determines the output voltage of the oscillator. With the type BF254A used here, the peak-to-peak value of output voltage is approximately equal to half the supply voltage, but it must be noted that the FET characteristics are subject to a considerable degree of device-to-device variation.

A type AD827 was selected for the opamp since it is fast enough to have a minimal effect on the oscillation conditions. The frequency is set to 143 kHz, since this value happens to fall nearly in the middle of the band from 140 kHz to 148.5 kHz (Cenelec standard 50065-1) when E24 values are used for the frequency-determining







COMPONENTS LIST

Resistors:
R1,R2 = 1k10 1%
R3 = 47kΩ
R4 = 22kΩ
R5,R18,R19 = 2kΩ2
R6,R7 = 1MΩ
R8,R10 = 10kΩ
R9,R16,R17 = 220kΩ
R11 = 4kΩ7
R12 = 1kΩ
R13,R14,R15 = 10Ω
P1 = 5kΩ preset

Capacitors:
C1,C2 = 1nF 1%
C3,C7 = 100pF
C4 = 1nF
C5,C6 = 470pF
C8 = 4nF7
C9 = 330nF
C10 = 1µF 275VAC, Class X2, lead pitch 27.5 mm
C11 = 100nF
C12,C14 = 10µF 63V radial
C13 = 100nF ceramic, lead pitch 5 mm
C15 = 470µF 25V radial

Semiconductors:
D1,D2,D3 = 1N4148
D4,D5 = zener diode 4V7 1.3W
T1,T2,T3 = BF245A
T4 = BD139
T5 = BD140
IC1 = AD827JN Analog Devices (Farnell)
IC2 = 7812

Miscellaneous:
K1 = 4-way pinheader
K2 = 2-way PCB terminal block, lead pitch 7.5mm
B1 = B80C1500 (rectangular case) (80V piv, 1.5A)
F1 = fuse, 32mAT (slow), with PCB mount holder and cap
Tr1 = 6:1 N30 core 16x6.3 mm EPCOS B64290L45X830 (Farnell)
Tr2 = mains transformer 15V >3VA, dims. 35x41mm, e.g., Hahn BV EI 382 1193 (15 V/4.5 VA) or Block VB 3,2/ 1/ 15 (15 V/3.2 VA, short-circuit resistant)

components. For general use, the maximum allowed voltage in this band is 116 dBµV.

The oscillator output is passed to the buffer stage IC1b via header K1. K1 provides the extra feature of allowing this signal to be modulated or coded using an external circuit. Depending on the circuit used for this purpose, it may be necessary to bypass C5. A potentiometer is placed at the input of IC1b to compensate for the tolerance variations of the oscillator. This allows the circuit to be adjusted to meet the requirements of the standard.

Two small power transistors (the ‘old faithfuls’ BD139 and BD140) are wired as complementary emitter followers in the output stage of the buffer. The quiescent current through the output stage depends on the voltage drop across D2/D3 and the value of the emitter resistors R13 and R14. Here the quiescent current is only a few milliampères. The maximum signal excursion is determined by the current sources T2 and T3 and the current gain of the output transistors. R12 provides better behaviour in the zero-crossing region.

In order to ensure a certain amount of isolation from the mains network, an output transformer (Tr1) is used. From the point of view of safety, though, it’s a good idea to regard the entire circuit as being connected to the mains potential and to bear this in mind when fitting it into an enclosure and using it in other applications. The primary winding of the transformer is driven via C9. The turns ratio of the transformer is chosen such that the maximum allowable value is achieved, but nothing significantly greater than this. Since the impedance of the mains network is a few tens of ohms, at 143 kHz a rather large capacitor (C10) is needed to isolate the 230-V mains voltage from the 143-kHz carrier signal. An X2 type must necessarily be used for this capacitor. R16 and R17 are placed in parallel with C10 to immediately discharge the voltage on K2 in the unlikely event that fuse F1 blows. R15, D4 and D5 protect the output of the amplifier stage against noise pulses and switch-on phenomena (i.e., against possible current spikes passing through C10).

Now for a couple of practical points. You will have to wind transformer Tr1 yourself, but this is not particularly difficult. The primary consists of 6 turns and the secondary is 1 turn. The core is an EPCOS type with a diameter of 16 mm, made from N30 material. Both windings are made using 1-mm diameter wire with synthetic insulation (total diameter 2.5 mm). The primary winding is split into two equal halves such that the secondary fits exactly between them. The leads of the transformer thus emerge on opposite sides. In order to increase the maximum insulation resistance, the original bare wire can be replaced by vanished wire.

The power supply follows the standard recipe of transformer, bridge rectifier and electrolytic capacitor, followed by a voltage regulator (IC2). Since the circuit operates from asymmetric supply voltages, voltage divider R18/R19 and decoupling capacitors C11/C12 are necessary to reference IC1 to half of the supply voltage. The supply voltage is also fed to connector K1 so that the stabilised +12 V is also available for possible expansion circuits.

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